# CP Algebra 1 Curriculum Maps

| Grade: 9<br>Subject: CP Alg 1 | Unit of Study: Relationships Between Quantities and Reasoning with Equations |
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| **Big Idea/Rationale** | Work with quantities and rates, including simple linear expressions and equations forms the foundation for this unit. Students use units to represent problems algebraically and graphically, and to guide the solution of problems. Student experience with quantity provides a foundation for the study of expressions, equations, and functions. This unit builds on earlier experiences with equations by asking students to analyze and explain the process of solving an equation. Students develop fluency writing, interpreting, and translating between various forms of linear equations and inequalities, and using them to solve problems. They master the solution of linear equations and apply related solution techniques and the laws of exponents to the creation and solution of simple exponential equations. |
| **Enduring Understanding (Mastery Objective)** | • Verbal expressions can be translated into mathematical expressions in order to solve real-world problems.<br>• The real numbers are classified according to their characteristics.<br>• Operations with exponents, powers, and square roots are often involved in real-world applications.<br>• Following the order of operations allows everyone to get the same answer when simplifying the same expression.<br>• The properties of real numbers are used to perform mental arithmetic and to simplify algebraic expressions.<br>• Equations are used in all areas of mathematics, as well as in other disciplines.<br>• Equations can range from simple to complex but the operations used to solve equations remains the same.<br>• A formula is a “literal equation” and can be rewritten to make the formula more convenient to use.<br>• The procedures for solving inequalities are the same as those for solving equations except when multiplying or dividing by a negative value.<br>• Proportions are special equations used in many fields, including construction, photography, and medicine.<br>• Percents have many common uses, such as calculating discounts, tips, sales tax, markups, and interest.<br>• The solutions to most inequalities are too numerous to list, so they are graphed. |
| **Essential Questions (Instructional Objective)** | • How can knowledge of words in our language be used to translate verbal expressions into mathematical expressions?<br>• How can a number line be used to perform operations with real numbers?<br>• How are numbers classified within the real number system?<br>• Why is it important to have an established “order of operations” in mathematics?<br>• How can the properties of real numbers assist you with mental math? |

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| | • How do you determine the operation needed to solve an equation?<br>• What does it mean for an equation to be an "identity" or a "contradiction" and how do you determine this through the process of solving the equation?<br>• How is rewriting a formula similar to solving an equation? How is it different?<br>• How are the skills learned in this unit applicable in the real world?<br>• How do you determine which side to shade the number line when graphing an inequality?<br>• What does an empty or solid circle and the direction of the arrow tell you about the solution of an inequality?<br>• How is solving inequalities similar to/different from solving equations?<br>• Why is it necessary to "flip" the inequality symbol when you multiply or divide by a negative number?<br>• How can you determine whether the solution of an inequality is all real numbers or no solutions?<br>• How do you know whether a graph represents a compound inequality that involves AND or OR?<br>• Why does an absolute-value inequality with a less than symbol indicate an AND statement and a greater than symbol indicate an OR statement? |
| **Content (Subject Matter)** | • Reason quantitatively and use units to solve problems.<br>• Interpret the structure of expressions.<br>• Create equations that describe numbers or relationships.<br>• Understand solving equations as a process of reasoning and explain the reasoning.<br>• Solve equations and inequalities in one variable. |
| **Skills/ Benchmarks (CCSS Standards)** | N.Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.<br>N.Q.2. Define appropriate quantities for the purpose of descriptive modeling.<br>N.Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.<br>A.SSE.1 Interpret expressions that represent a quantity in terms of its context.★<br>a. Interpret parts of an expression, such as terms, factors, and coefficients.<br>b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)n as the product of P and a factor not depending on P.*<br>A.CED.1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*<br>A.CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.<br>A.CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable |

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| | options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*<br>A.CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*<br>A.REI.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.<br>A.REI.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.N.RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define 51/3 to be the cube root of 5 because we want (51/3)3 = 5(1/3)3 to hold, so (51/3)3 must equal 5.* |
| **Materials and Resources** | Mimio software, Mimio clickers, document camera, pencils, graph paper, graphing calculators, rulers, tape, glue, scrap paper, Holt Algebra 1 textbook, algebra tiles, smartpals, and classroom whiteboards. |
| **Notes** | |

| Grade: 9<br>Subject: CP Alg 1 | Unit of Study: Linear and Exponential Relationships |
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| **Big Idea/Rationale** | Building on earlier work with linear relationships, students learn function notation and language for describing characteristics of functions, including the concepts of domain and range. They explore many examples of functions, including sequences; they interpret functions given graphically, numerically, symbolically, and verbally, translate between representations, and understand the limitations of various representations. They work with functions given by graphs and tables, keeping in mind that depending upon the context, these representations are likely to be approximate and incomplete. Their work includes functions that can be described or approximated by formulas as well as those that cannot. When functions describe relationships between quantities arising from a context, students reason with the units in which those quantities are measured. Students explore systems of equations and inequalities, and they find and interpret their solutions. Students build on and informally extend their understanding of integral exponents to consider exponential functions. They compare and contrast linear and exponential functions, distinguishing between additive and multiplicative change. They interpret arithmetic sequences as linear functions and geometric sequences as exponential functions. |
| **Enduring Understanding (Mastery Objective)** | • Functions are used in a variety of ways to describe real world relationships.<br>• Functions can be used to make predictions and identify trends.<br>• Patterns can often be written as a rule in mathematics.<br>• Technology is a beneficial tool when examining patterns.<br>• Linear functions describe numerous real-world situations that involve constant rates of change, such as cost, distance, and speed.<br>• When a linear equation is written in certain forms, relevant information about the graph can be gathered from the equation.<br>• Systems of linear equations or inequalities are used to represent situations and solve problems involving consumer economics, finance, and geometry.<br>• Special systems of linear equations can represent real-world business situations in which there are no solutions or infinitely many solutions.<br>• Systems of equations can be solved using various methods with each one having strengths and weaknesses.<br>• The graph of a system of linear inequalities can help business owners make decisions that are based on several constraints.<br>• Integer exponents are used to express measurements that are very large or very small.<br>• Scatter plots and trend lines provide a way to make predictions using data sets. |
| **Essential Questions (Instructional Objective)** | • How do discrete and continuous relations and graphs differ?<br>• Why is it useful to represent numerical situations algebraically?<br>• How do you determine if a relation represents a function when given a table, a mapping, or a graph of the data? |

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| | • How is evaluating a function like solving an equation? How is it different?<br>• What does a scatter plot look like if there is no correlation between the data sets? Positive correlation? Negative correlation?<br>• What factors could affect the accuracy of a prediction when using a scatter plot and trend line?<br>• How is identifying an arithmetic sequence similar to identifying a function rule?<br>• How do arithmetic and geometric sequences differ? How are they the same?<br>• What is required in order for an equation to be a "function"?<br>• How do you determine if a function is a linear function?<br>• What is the difference between graphing a line using intercepts and graphing a line by generating a table of ordered pairs?<br>• How does a constant rate of change relate to the slope of a line?<br>• How do you switch from point-slope form to slope-intercept form?<br>• How can slope be used to determine if one line is steeper than another?<br>• How is the graph of an absolute function similar/different from the graph of a linear function?<br>• What are the different methods that can be used to solve a system of equations and what are the strengths and weaknesses of each method?<br>• How are systems of equations and inequalities applicable in the real world?<br>• How can businesses use systems of equations or inequalities in making good business decisions?<br>• Why would one representation of a numerical expression be more useful than another?<br>• How do we model situations using exponents? |
| **Content (Subject Matter)** | • Extend the properties of exponents to rational exponents.<br>• Analyze and solve linear equations and pairs of simultaneous linear equations.<br>• Solve systems of equations.<br>• Represent and solve equations and inequalities graphically.<br>• Define, evaluate, and compare functions.<br>• Understand the concept of a function and use function notation.<br>• Use functions to model relationships between quantities.<br>• Interpret functions that arise in applications in terms of a context.<br>• Analyze functions using different representations.<br>• Build a function that models a relationship between two quantities.<br>• Build new functions from existing functions.<br>• Construct and compare linear, quadratic, and exponential models and solve problems.<br>• Interpret expressions for functions in terms of the situation they model. |

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| **Skills/ Benchmarks (CCSS Standards)** | N.RN.2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.<br>A.REI.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.<br>A.REI.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.<br>A.REI.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).<br>A.REI.11. Explain why the *x*-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★<br>A.REI.12. Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.<br>F.IF.1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If $f$ is a function and x is an element of its domain, then $f(x)$ denotes the output of $f$ corresponding to the input $x$. The graph of $f$ is the graph of the equation $y = f(x)$.<br>F.IF.2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.<br>F.IF.3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by* $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ *for* $n \geq 1$.<br>F.IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*★<br>F.IF.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*★<br>F.IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.★<br>F.IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated |

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| | cases.★<br>a. Graph linear and quadratic functions and show intercepts, maxima, and minima.<br>e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.<br>F.IF.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.<br>F.BF.1. Write a function that describes a relationship between two quantities.★<br>a. Determine an explicit expression, a recursive process, or steps for calculation from a context.<br>b. Combine standard function types using arithmetic operations.<br>*For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*<br>F.BF.2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.★<br>F.BF.3. Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of $k$ given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. *Include recognizing even and odd functions from their graphs and algebraic expressions for them*.<br>F.LE.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.<br>a. Prove that linear functions grow by equal differences over equal intervals; and that exponential functions grow by equal factors over equal intervals.<br>b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.<br>c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.<br>F.LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).<br>F.LE.3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.<br>F.LE.5. Interpret the parameters in a linear or exponential function in terms of a context. |
| **Materials and Resources** | Mimio software, Mimio clickers, document camera, pencils, graph paper, graphing calculators, rulers, tape, glue, scrap paper, Holt Algebra 1 textbook, algebra tiles, smartpals, and classroom whiteboards. |

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| **Notes** | |

| Grade: 9<br>Subject: CP Alg 1 | Unit of Study: Descriptive Statistics |
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| **Big Idea/Rationale** | Students use regression techniques to describe relationships between quantities. They use graphical representations and knowledge of the context to make judgments about the appropriateness of linear models. With linear models, they look at residuals to analyze the goodness of fit. |
| **Enduring Understanding (Mastery Objective)** | • Descriptive statistics is a branch of statistics that involves the organization, summarization, and display of data.<br>• Data can be displayed in various ways with each having advantages and disadvantages.<br>• Scatter plots and trend lines provide a way to determine correlation measures of data.<br>• A measure of central tendency is a value that represents a typical entry of a data set.<br>• Mean, median, mode, and range are measures of central tendency.<br>• A study of descriptive statistics leads to an understanding of probability. |
| **Essential Questions (Instructional Objective)** | • What are the various forms in which data can be displayed and when is it appropriate to use each form?<br>• How do you determine measures of central tendency?<br>• How can correlation be used to describe data?<br>• How does correlation differ from causation?<br>• What is the relation between probability and odds?<br>• How are permutations and combinations different? How are they alike? |
| **Content (Subject Matter)** | • Summarize, represent, and interpret data on a single count or measurement variable.<br>• Investigate patterns of association in bivariate data.<br>• Summarize, represent, and interpret data on two categorical and quantitative variables.<br>• Interpret linear models. |
| **Skills/ Benchmarks (CCSS Standards)** | S.ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots).<br>S.ID.2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.<br>S.ID.3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).<br>S.ID.5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.<br>S.ID.6. Represent data on two quantitative variables on a scatter plot, and |

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| | describe how the variables are related.<br>a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. *Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.*<br>b. Informally assess the fit of a function by plotting and analyzing residuals.<br>c. Fit a linear function for a scatter plot that suggests a linear association.<br>S.ID.7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.<br>S.ID.8. Compute (using technology) and interpret the correlation coefficient of a linear fit.<br>S.ID.9. Distinguish between correlation and causation. |
| **Materials and Resources** | Mimio software, Mimio clickers, document camera, pencils, graph paper, graphing calculators, rulers, tape, glue, scrap paper, Holt Algebra 1 textbook, algebra tiles, smartpals, and classroom whiteboards. |
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| Grade: 9<br>Subject: CP Alg 1 | **Unit of Study: Expressions and Equations** |
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| **Big Idea/Rationale** | In this unit, students build on their knowledge from unit 2, where they extended the laws of exponents to rational exponents. Students apply this new understanding of number and strengthen their ability to see structure in and create quadratic and exponential expressions. They create and solve equations, inequalities, and systems of equations involving quadratic expressions. |
| **Enduring Understanding (Mastery Objective)** | • Polynomials can be used to represent various measurements, including perimeter, area, and volume.<br>• Performing operations with polynomial expressions is a basis for higher-level mathematics.<br>• Many real-world events are best modeled by a quadratic function.<br>• Quadratic functions can be solved in various ways with each having its advantages and disadvantages. |
| **Essential Questions (Instructional Objective)** | • Why would one representation of a numerical expression be more useful than another?<br>• How do we model situations using exponents?<br>• Where do we use polynomials in real life?<br>• How can the graph of a quadratic model be used to find solutions to real-world problems?<br>• What are the advantages and disadvantages of the various methods for solving quadratic functions? |
| **Content (Subject Matter)** | • Interpret the structure of expressions.<br>• Write expressions in equivalent forms to solve problems.<br>• Perform arithmetic operations on polynomials.<br>• Create equations that describe numbers or relationships.<br>• Solve equations and inequalities in one variable.<br>• Solve systems of equations. |
| **Skills/ Benchmarks (CCSS Standards)** | A.SSE.1. Interpret expressions that represent a quantity in terms of its context. ★<br>a. Interpret parts of an expression, such as terms, factors, and coefficients.<br>b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret* $P(1+r)^n$ *as the product of P and a factor not depending on P.*<br>A.SSE.2. Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 – y^4$ *as* $(x^2)^2 – (y^2)^2$*, thus recognizing it as a difference of squares that can be factored as* $(x^2 – y^2)(x^2 + y^2)$*.*<br>A.SSE.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.★<br>a. Factor a quadratic expression to reveal the zeros of the function it defines.<br>b. Complete the square in a quadratic expression to reveal the maximum or |

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| | minimum value of the function it defines.<br>c. Use the properties of exponents to transform expressions for exponential functions. *For example the expression $1.15^t$ can be rewritten as $(1.151/12)^{12t} \approx 1.012^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.*<br>A.APR.1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.<br>A.CED.1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions*.<br>A.CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.<br>A.CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law $V = IR$ to highlight resistance $R$.*<br>A.REI.4. Solve quadratic equations in one variable.<br>a. Use the method of completing the square to transform any quadratic equation in $x$ into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.<br>b. Solve quadratic equations by inspection (e.g., for $x2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers $a$ and $b$.<br>A.REI.7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. *For example, find the points of intersection between the line $y = –3x$ and the circle $x^2 + y^2 = 3$.* |
| **Materials and Resources** | Mimio software, Mimio clickers, document camera, pencils, graph paper, graphing calculators, rulers, tape, glue, scrap paper, Holt Algebra 1 textbook, algebra tiles, smartpals, and classroom whiteboards. |
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| Grade: 9<br>Subject: CP Alg 1 | **Unit of Study: Quadratic Functions and Modeling** |
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| **Big Idea/Rationale** | In preparation for work with quadratic relationships students explore distinctions between rational and irrational numbers. They consider quadratic functions, comparing the key characteristics of quadratic functions to those of linear and exponential functions. They select from among these functions to model phenomena. Students learn to anticipate the graph of a quadratic function by interpreting various forms of quadratic expressions. In particular, they identify the real solutions of a quadratic equation as the zeros of a related quadratic function. Students learn that when quadratic equations do not have real solutions the number system must be extended so that solutions exist, analogous to the way in which extending the whole numbers to the negative numbers allows $x+1 = 0$ to have a solution. Formal work with complex numbers comes in Algebra II. Students expand their experience with functions to include more specialized functions—absolute value, step, and those that are piecewise-defined. |
| **Enduring Understanding (Mastery Objective)** | • Quadratic equations exist and are a regular occurrence in mathematics and the world around us.<br>• Many real-world events are best modeled by a quadratic model which makes solving quadratic equations a critical skill for problem solving.<br>• Analyzing the reasonableness of your answer allows you to gain a better understanding of the material.<br>• Mathematical models can be used to describe physical relationships; these relationships are often non-linear.<br>• The knowledge of quadratic equations is a basis for higher level mathematics.<br>• Radical and rational equations often have excluded values.<br>• The Pythagorean Theorem provides an efficient way to determine a missing side of a right triangle. |
| **Essential Questions (Instructional Objective)** | • Where in real life do we solve quadratic equations?<br>• How do you know when a result is reasonable?<br>• What types of situations require certain models of quadratics?<br>• What is the difference between factoring a quadratic expression and solving a quadratic equation?<br>• What are the different methods that can be used to solve a quadratic equation?<br>• How do you identify the excluded values for radical and rational equations?<br>• How can you verify the validity of the Pythagorean Theorem? |
| **Content (Subject Matter)** | • Use properties of rational and irrational numbers.<br>• Understand and apply the Pythagorean Theorem.<br>• Interpret functions that arise in applications in terms of a context.<br>• Analyze functions using different representations. |

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| | • Build a function that models a relationship between two quantities.<br>• Build new functions from existing functions.<br>• Construct and compare linear, quadratic and exponential models and solve problems. |
| **Skills/ Benchmarks (CCSS Standards)** | N.RN.3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.<br>F.IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*★<br>F.IF.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*★<br>F.IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.★<br>F.IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★<br>a. Graph linear and quadratic functions and show intercepts, maxima, and minima.<br>b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.<br>F.IF.8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.<br>a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.<br>b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as* $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, *and classify them as representing exponential growth or decay.*<br>F.IF.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*<br>F.BF.1. Write a function that describes a relationship between two quantities. ★<br>a. Determine an explicit expression, a recursive process, or steps for |

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| | calculation from a context.<br>b. Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*<br>F.BF.3. Identify the effect on the graph of replacing *f(x)* by *f(x) + k, k f(x), f(kx),* and *f(x + k)* for specific values of *k* (both positive and negative); find the value of *k* given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. *Include recognizing even and odd functions from their graphs and algebraic expressions for them.*<br>F.BF.4. Find inverse functions.<br>a. Solve an equation of the form *f(x) = c* for a simple function *f* that has an inverse and write an expression for the inverse. *For example,* $f(x) = 2x^3$ *for* $x > 0$ *or* $f(x) = (x+1)/(x-1)$ *for* $x \neq 1$.<br>F.LE.3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. |
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